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PHYTOTOXICOLOGY 1995 INVESTIGATION: FORD ESSEX ALUMINUM PLANT WINDSOR

MAY 1998

Ontario

Ministry
of the
Environment

ISBN 0-7778-7447-4

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Report No: SDB-011-3511-1997

Background:

Ford Motor Company of Canada Limited, and the affiliated Ford Ensite International Inc., operate the Essex Aluminum Plant. This plant, referred to as 'Ford Essex' in this report, is located at 6500 Cantelon Drive in the western part of the City of Windsor.

Aluminum metal scrap is melted in two rotary furnaces and cast into automotive engine components. A flux consisting of NaCl, KCl and $KalF_4$ is added to the furnaces to prevent oxidation and remove impurities. The molten aluminum is transferred to holding furnaces and then to pouring ladles. While in the ladles, a mixture of Cl_2 and N_2 gases is bubbled through the molten aluminum to remove dissolved gases that would create voids in the finished casting.

These procedures have the potential to emit hydrofluoric acid (HF) and hydrochloric acid (HCl). Prior to 1994, emissions from the rotary furnaces were vented through baghouses to control particulate releases only. In 1994, Ford Essex installed exhaust gas scrubbers to minimize the release of these acid gases. After some modifications, these scrubbers were reported to have reduced acid gas release to the point where, during an August 1995 survey, the MOEE TAGA 6000, a mobile tandem mass spectrometer, failed to detect either HF or HCl in the vicinity of the plant. Prior to the installation of the scrubbers, the TAGA 6000 reported frequent and substantial exceedences of the Air Quality Standard for both acid gases.

Previous Phytotoxicology Investigations:

The Phytotoxicology Section conducted its first investigation around this plant in 1992 and followed up in 1993 and 1994. These investigations consisted of collections of grass tissue and tree foliage at various locations around the plant. Chemical analysis of the samples provided a biological indicator of emissions of fluoride and chloride compounds from the Ford Essex processes. Vegetation was also examined for signs of acute injury that could be ascribed to the acid gases, especially HF.

The results of these investigations were reported in three MOEE reports. These three documents were assigned the following report numbers:

HCB-012-3512-93	(1992 investigation)
SDB-043-3512-94	(1993 investigation)
SDB-033-3511-95TM	(1994 investigation)

The 1992 investigation was conducted in August of that year and consisted of collections and chemical analysis of grass samples from 20 locations. Five locations were aligned along each of four transect lines following the principal compass points, to distances of about 1000 metres. Foliage from four silver maple trees, one from each transect line, was also collected. These trees were the nearest silver maple trees to Ford Essex along each respective transect line.

The 1992 investigation confirmed that Ford Essex was a source of fluoride. However, the timing of the collection, which occurred a few weeks after a scheduled summer shut-down of operations at Ford Essex, coupled with the probable grass mowing activity at many of the

sampling sites, made it impossible to quantify the effect of fluoride emissions on foliar concentrations of fluoride.

The 1993 and 1994 investigations repeated the grass sampling at the 20 locations. However, these collections took place in late June, just prior to the July shut-down. Silver maple foliage was collected at nine locations, the original four plus five new locations. The tree foliage collection was performed at the end of September to provide as long an exposure period as possible. The data from these collections continued to point to Ford Essex as the fluoride source. Chlorine concentrations in the vegetation samples could not be used to define an emitting source because of the naturally high background concentrations of this element in vegetation. This is particularly a problem in the extreme southwestern part of Ontario.

The fluoride concentrations in the grass samples collected in 1994 were substantially lower than in 1992 or 1993. Meanwhile the 1994 silver maple foliar fluoride concentrations did not exhibit such dramatic reductions. Elevated concentrations were also apparent over a wider geographic area.

1995 Phytotoxicology Investigations:

After reviewing the three data sets for the fluoride concentrations in grass tissue, it was concluded that grass was not a suitable material to monitor the effects of the fluoride emissions from Ford Essex. It was not possible to ascertain that the grass tissue available at a given site was all exposed for an equal period of time. Grass mowing at some locations and different growth and senescence rates for different species would all contribute to tissue samples that had been exposed differently. Although proven to be an effective investigative tool in rural areas, grass sampling may be less useful in urban communities where landscaping is more prevalent.

In 1995, the grass collections were discontinued, and the silver maple collections were enhanced by establishing three new sampling locations. These were not located along any particular transect line, but did occur to the north of the plant, downwind of the most frequent wind direction. These three new stations were specifically selected to be as close to Ford Essex as possible, yet not be located on company property. Figure 1 consists of a map showing the locations of all silver maples sampled in 1995.

The collection took place on September 26, 1995. Silver maple foliage samples were collected by cutting a branch from the side of the canopy facing Ford Essex, removing the leaves and placing them into labelled kraft bags. Duplicate samples were collected. During this collection, other vegetation near the silver maple was examined for evidence of fluoride injury.

The samples were delivered to the Phytotoxicology processing laboratory where non-foliar material (seeds, twigs) was removed. The foliage was then dried in a forced-draft oven and ground in a stainless steel, rotating-blade (Wiley^{TM}) mill to pass through a one millimetre screen. Flint glass jars with polyethylene lids were used to contain the processed samples.

The samples were forwarded to the MOEE Laboratory Services Branch where the material was analysed for fluoride. Briefly, the analysis involved extracting the sample in a weak

acid solution and determining the fluoride ion concentration by a specific ion electrode.

Figure 1: **Silver Maple Foliage Sampling Locations in the Vicinity of the Ford Essex Aluminum Plant, Windsor - 1995 Investigation Results**

The results of the chemical analyses of the silver maple samples, expressed as means of the duplicates, are given in the table on the following page. This table also contains Upper Limit of Normal (ULN) concentration guidelines for fluoride in tree foliage. The ULN guidelines are explained in the appendix to this report.

The concentrations of fluoride in the silver maple foliage samples, as determined for the 1995 samples, are presented graphically in Figures 2, along with the concomitant data from the

preceding collections of 1992 through 1994.

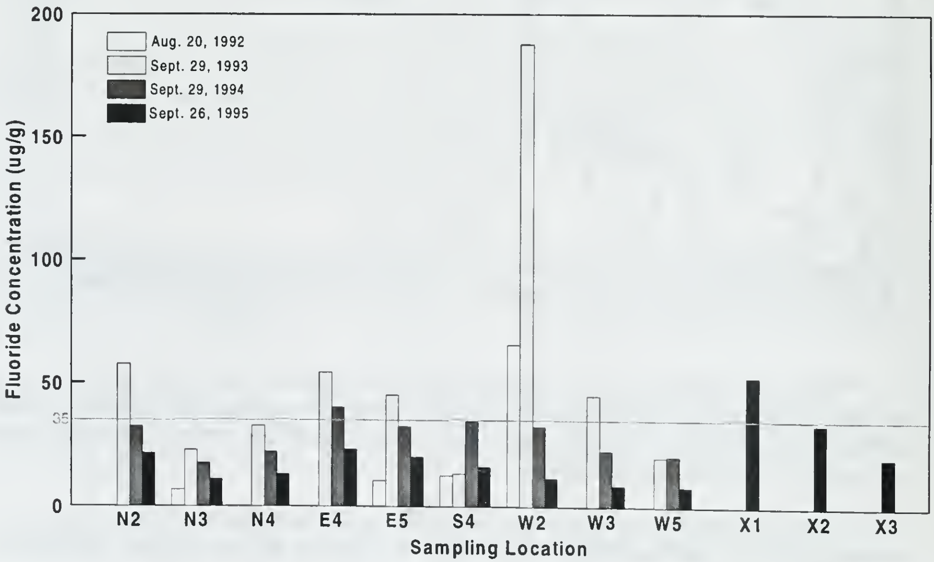
Observations of the foliage from the trees sampled in 1995, as well as foliage from other species in the vicinity, failed to reveal any evidence of injury that could be attributed to HF. Such injury was observed during previous investigations.

Location	Concentration	Location	Concentration
N2	22	W3	8.7
N3	11	W5	8.1
N4	13	X1	53
E4	23	X2	34
E5	20	X3	20
S4	16		
W2	12	ULN	35

Mean Fluoride Concentrations (micrograms per gram) in Silver Maple Foliage in the Vicinity of the Ford Essex Aluminum Plant, Windsor, September 26, 1995

ULN = Upper Limit of Normal Guideline for urban tree foliage (see Appendix)

Figure 2: Fluoride Concentrations in Silver Maple Foliage in the Vicinity of the Ford Essex Aluminum Plant, 1992 to 1995



Discussion:

By the time the 1995 Phytotoxicology investigation was conducted, the new dry-lime injection system to control acid gas emissions was fully operational. This system was installed in the latter part of 1993 but was then subject to modifications. The TAGA 6000 survey in 1994 still recorded exceedences of the one half-hour Air Quality Standard for HF of 4.3 micrograms per cubic metre (ug/m^3). However the exceedences were not as frequent or pronounced as in 1992, prior to any acid gas emission controls. By 1995, the TAGA 6000 could not detect HF at a detection limit of less than 1 ug/m^3.

These observations are supported by the foliar fluoride concentrations, which show a progressive decline from 1993 through 1995. The 1992 collection is not being considered in this analysis because the timing of the collection just after the summer shut-down was so different from the subsequent late September collections.

The 1993 foliage collection took place prior to the commissioning of the control system. The 1994 collection took place after the commissioning but before the required modifications were made. The 1995 collection was performed when the system was fully operational and after the TAGA 6000 had completed its August survey, which failed to detect HF. Figure 1 shows that, with one exception, the fluoride concentrations in silver maple foliage at the nine locations sampled in 1993, 1994 and 1995, have become progressively lower. The concentrations at these nine locations are also below the ULN guideline for fluoride in urban tree foliage.

The three new sampling locations established for the 1995 investigation and designated X1, X2 and X3, could not be compared in the same way. One of these locations, X1, had the highest fluoride concentration of the 1995 collection (53 ug/g), exceeding the ULN guideline. Location X2 had the second highest concentration. These observations suggest that Ford Essex is still a source of fluoride. However, to ascertain this required sampling of tree foliage very close to and directly downwind of the aluminum casting facility. The foliar concentration data from the original nine stations also revealed trends of declining concentrations at greater distances from Ford Essex, but these trends were weak and without the supporting evidence from the new stations, would not be able to demonstrate that Ford Essex was still a source of fluoride.

Conclusions and Recommendations:

Collectively, the evidence provided by the foliage collections, as well as the TAGA 6000 surveys, reveals that hydrogen fluoride emissions from the Ford Essex plant have been substantially abated. Although analysis of tree foliage indicates that fluorides are still being emitted, and are measurable in the terrestrial environment, the ambient air concentrations are not exceeding the Air Quality Standard and most species of plants would not be injured by the foliar concentrations revealed in this investigation.

It is recommended that a Phytotoxicology investigation following the most recent design be conducted in 1997. If similar, low degrees of foliar contamination are still indicated, then investigations at three to five year intervals would be adequate to ensure that the successful

APPENDIX

Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: Ontario Ministry of the Environment, 1989, ↕◊Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples↕, Phytotoxicology Section, Air Resources Branch; Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto, ISBN 0-7729-5143-8). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.